

SIMILARLY POSITIONED IN THE NON- DYSMORPHIC PELVIS?

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POSTERIOR PELVIC RING FRACTURES

- Pediatric pelvic ring fractures are rare
- Historically treated Non-operatively
- Low Mortality
- Long term morbidity
 - Lumbar Pain
 - Trendelenburg Sign
 - Nonstructural Scoliosis

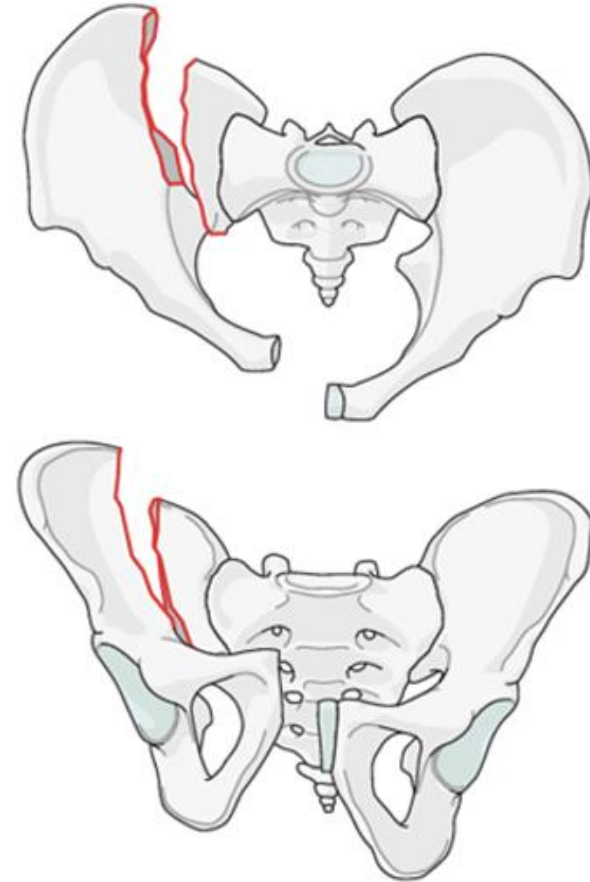


Figure 1



PERCUTANEOUS SACROILIAC SCREW FIXATION

- Three view intraoperative fluoroscopically guided procedure
 - Inlet, outlet, and True Sacral lateral view
 - 2-D representations used to guide screw trajectory
- Technically challenging with 8% iatrogenic neurovascular injury (adult)
 - L5 nerve root and iliac arteries anterior
 - S1 nerve root posterior

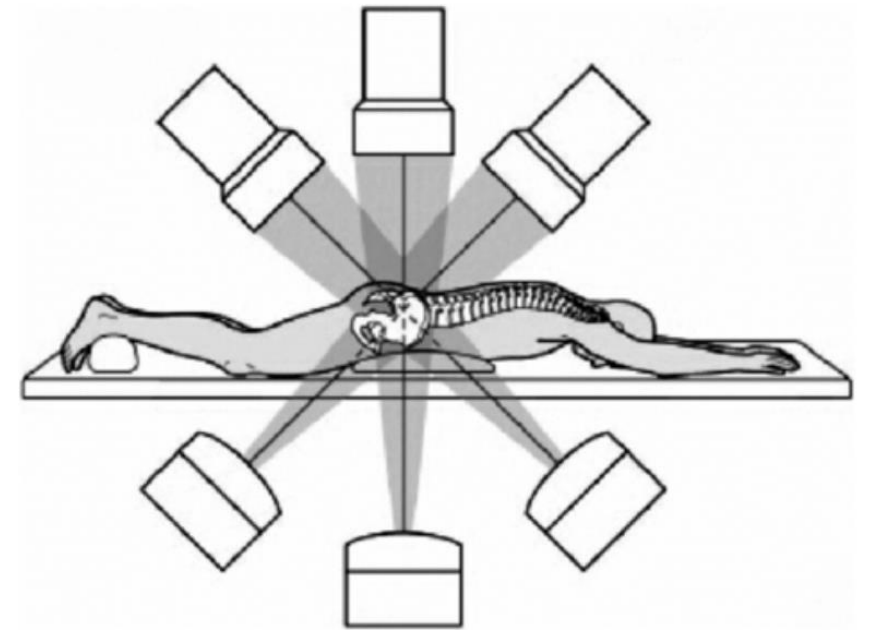
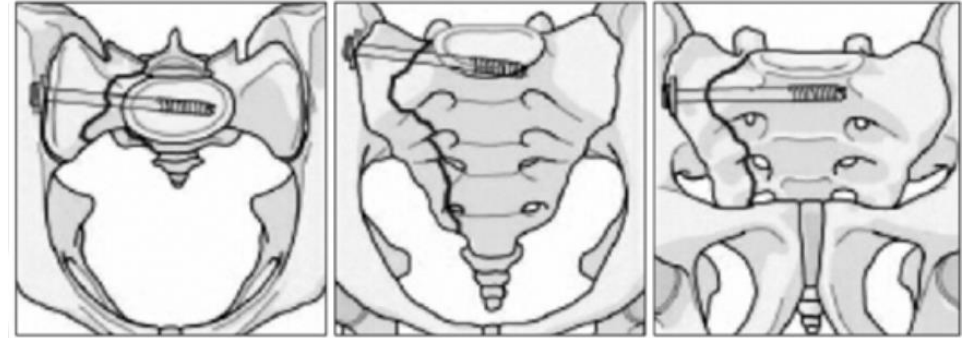


Figure 2



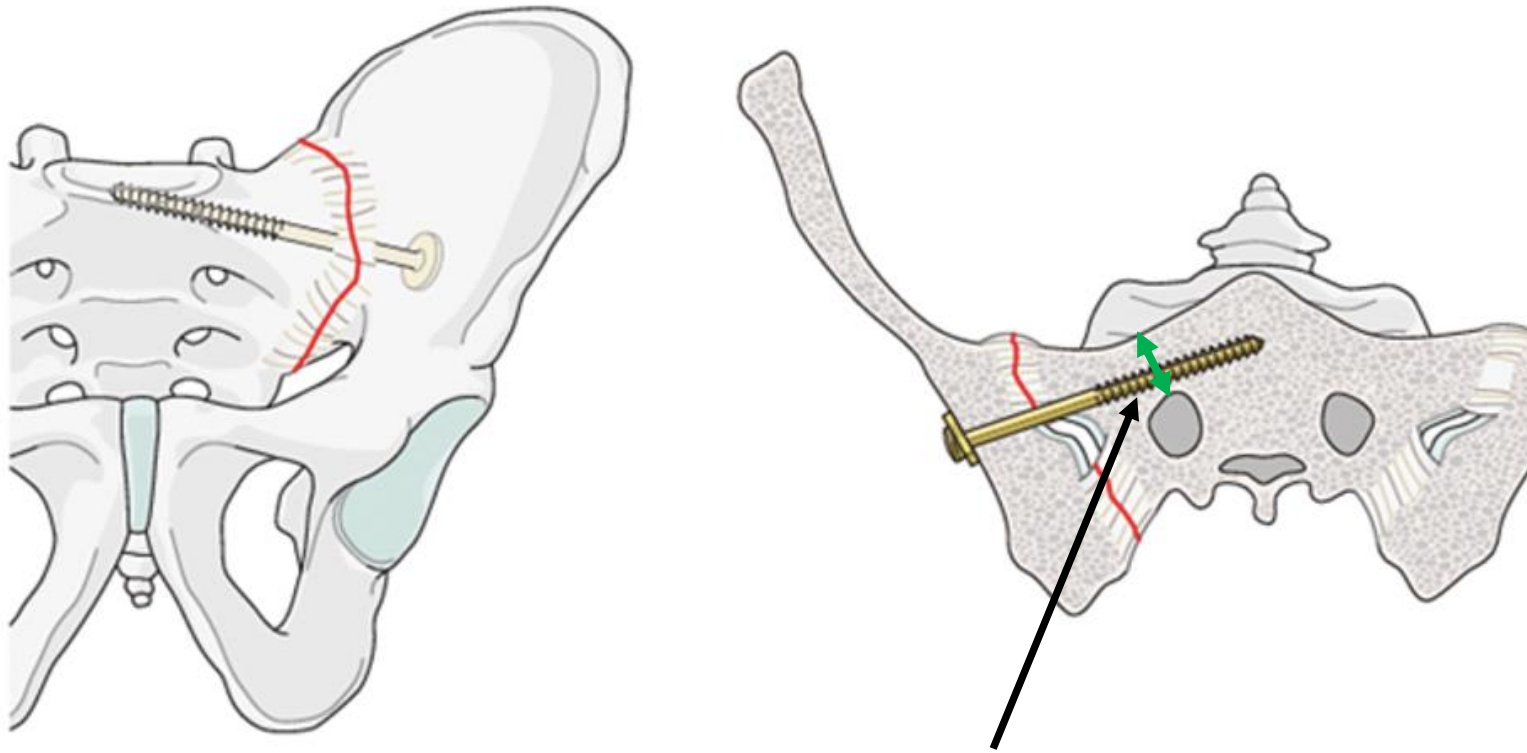


Figure 3

SAFE ZONE

- Osseous pathway from Ilium → Sacral ala → S1 Vertebral body
- Screw must be contained within
- Final trajectory confirmed on true lateral projection (sagittal)
 - Iliac cortical density is key anatomic landmark



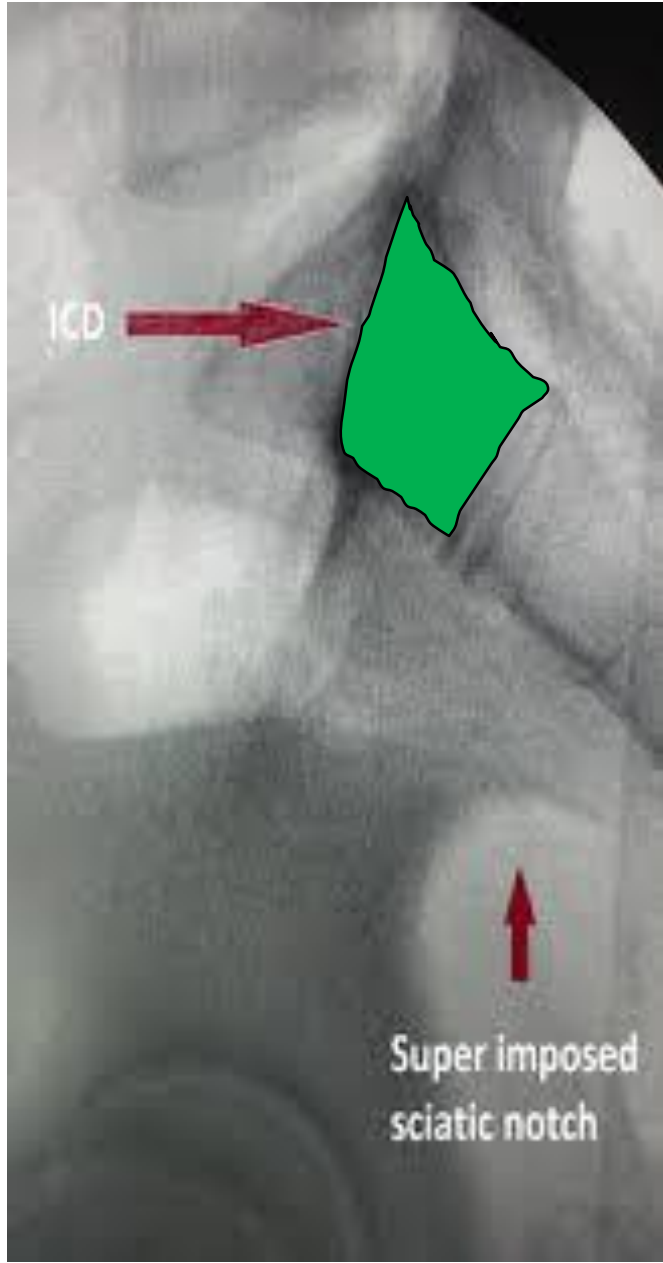
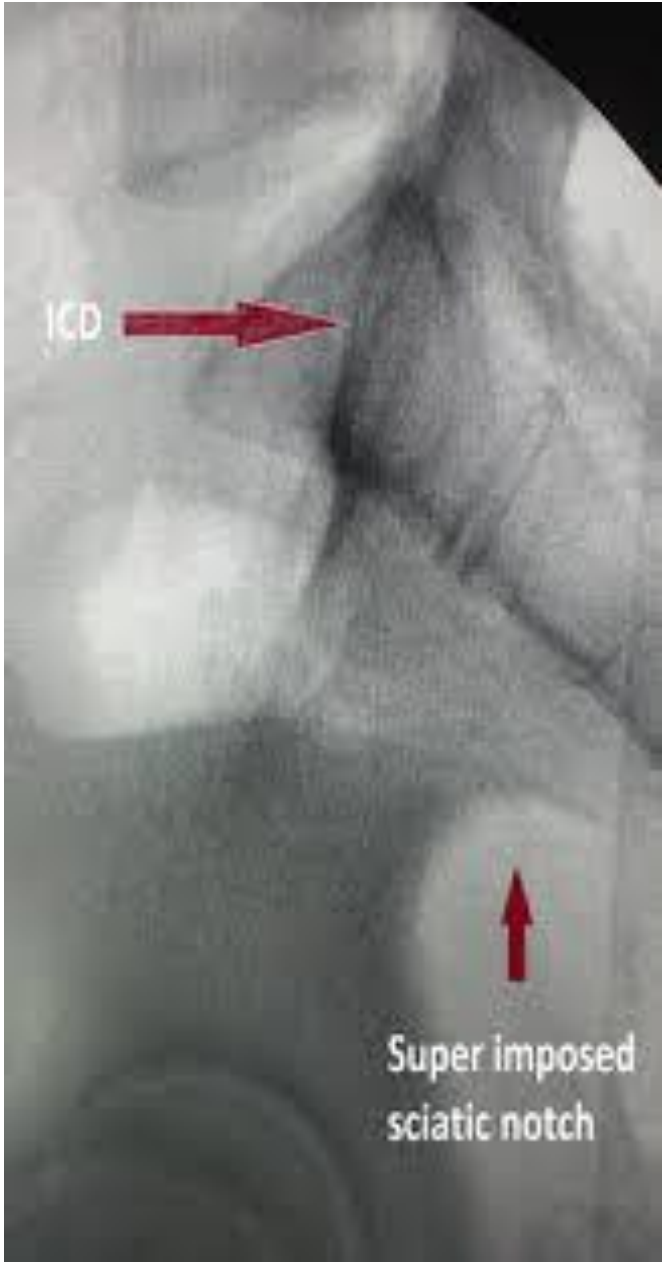


Figure 4



STUDY PURPOSE

Investigate whether the ICD is a safe and accurate guide for the trajectory of SI screws in the developing pelvis

Quantify any evolving relationship of the “safe zone” during development



SUBJECTS

- Retrospective Review of CT scans (1/2015-6/2019)
- Patients divided into representative age groups
 - (0-2), (3-4), (5-7), (8-10), (11-13), (14-16)
- **Exclusion criteria:**
 - Pelvic trauma
 - Congenital defect
 - Pelvic dysmorphism
 - Neuromuscular disease
 - Non-ambulatory status

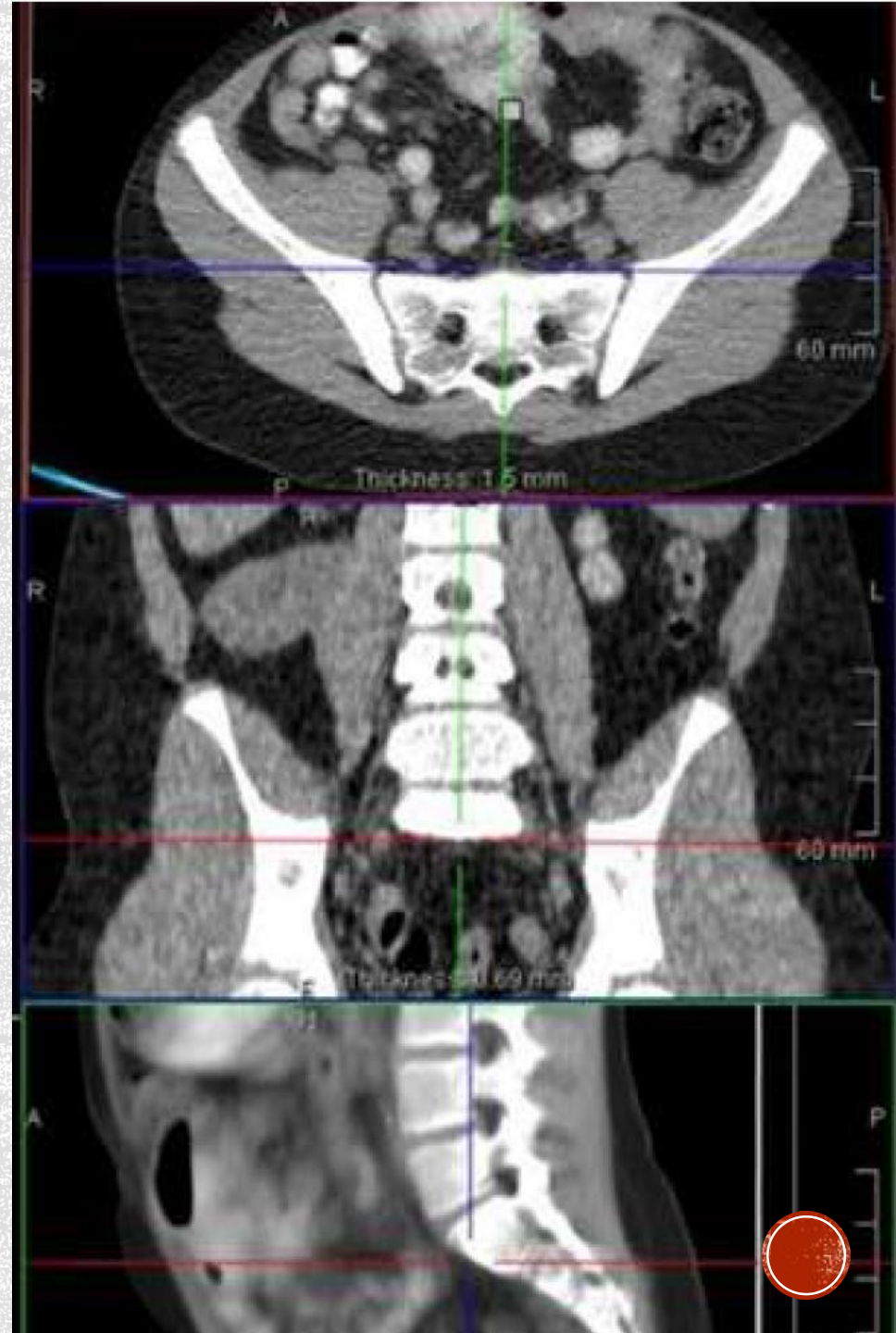


Figure 5

Measurements from 181 patients

40.3% female

59.7% male



30 Cases per age group



ICD clearly and reliably visible across age groups

Inter-rater reliability 0.91

Intra-rater reliability 0.89

RESULTS



Tables/Figures:

Table 1. Average S1 vertebral body and iliac cortical density height by location

Age Group	Vertebral Height by Location, mm, mean ± sd					
	Anterior S1	Anterior ICD	Midpoint S1	Midpoint ICD	Posterior S1	Posterior ICD
0-2 Years (n=30)	10.0 ± 2.2	2.2 ± 0.7	10.9 ± 2.3	5.3 ± 2.1	8.9 ± 1.9	6.3 ± 2.1
3-4 Years (n=31)	14.4 ± 1.7	4.2 ± 1.7	15.1 ± 1.3	7.9 ± 2.2	12.1 ± 1.4	9.1 ± 1.6
5-7 Years (n=30)	16.6 ± 1.9	5.8 ± 1.8	17.8 ± 1.8	10.5 ± 3.1	15.3 ± 1.8	12.2 ± 2.5
8-10 Years (n=30)	21.7 ± 2.2	8.6 ± 1.6	21.7 ± 2.1	13 ± 2.5	18.6 ± 2.1	15.3 ± 2.8
11-13 Years (n=30)	25.7 ± 2.3	12.82 ± 2.0	25.3 ± 1.9	16.8 ± 2.8	21.9 ± 2.5	19.2 ± 2.9
14-16 Years (n=30)	30.1 ± 3.2	16.7 ± 2.5	28.8 ± 2.8	19.9 ± 2.9	25.6 ± 3.2	22.5 ± 3.6
ANOVA Between Groups	p < 0.001	p < 0.001	p < 0.001	p < 0.001	p < 0.001	p < 0.001

Abbreviations: ICD, iliac cortical density



Table 2. Proportion of vertebral height overlapped by the iliac cortical density at three locations

Age Group	ICD / S1 Vertebral Height Overlap Ratio, %, mean \pm sd		
	Anterior	Midpoint	Posterior
0-2 Years (n=30)	↓ 22.2 \pm 5.5	↓ 47.3 \pm 13.7	↓ 69.7 \pm 13.8
3-4 Years (n=31)	28.8 \pm 9.6	52.6 \pm 11.8	74.8 \pm 8.3
5-7 Years (n=30)	34.7 \pm 8.1	58.4 \pm 14.3	79.5 \pm 10.1
8-10 Years (n=30)	39.5 \pm 6.9	60.3 \pm 12.0	81.9 \pm 10.1
11-13 Years (n=30)	49.2 \pm 7.0	66.2 \pm 8.7	87.3 \pm 6.9
14-16 Years (n=30)	↓ 55.2 \pm 5.4	↓ 69.1 \pm 6.0	↓ 88.1 \pm 7.0
ANOVA Between Groups	p < 0.001	p < 0.001	p < 0.001

Abbreviations: ICD, iliac cortical density



Age Group	
0-2 Years	
3-4 Years	
5-7 Years	
8-10 Years	
11-13 Years	
14-16 Years	

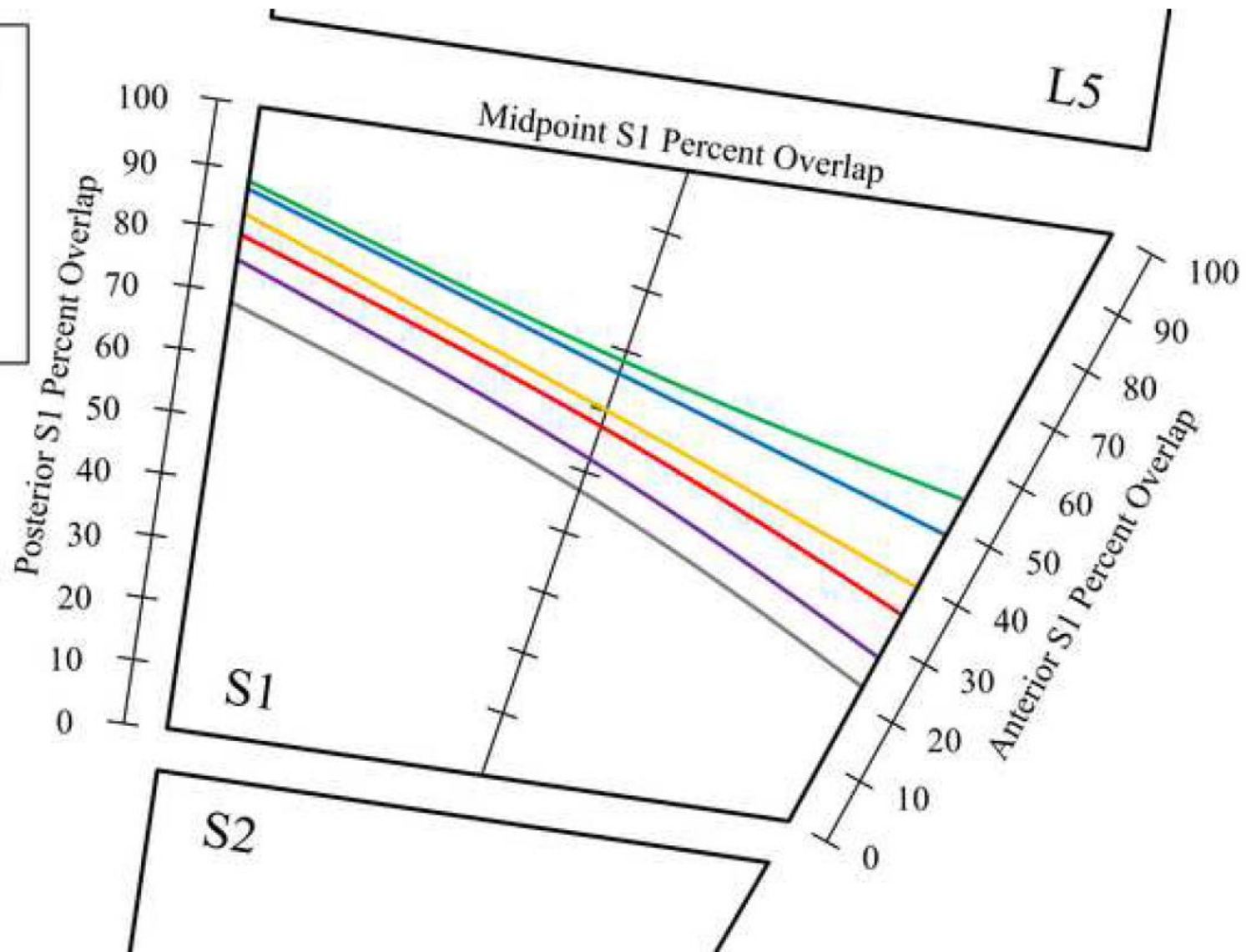


Figure 7



DISCUSSION

- Complex 3-D anatomy using 2-D landmarks for proper screw trajectory
- Paucity of investigation in assessment of adult landmarks during development
- The ICD can be reliably applied to the pediatric pelvis
- Unrecognized relationship is crucial for operative decision making in the pediatric pelvis, especially in the youngest age groups
- Progressive increase in "safe zone height" and proportional overlap of S1
 - Translates to relative expansion of the safe zone across age groups
 - Variation in regional growth patterns



LIMITATIONS

- Clinical software
- Human error in manual distance measurement
- CT resolution quality
 - Softening of osseous edges



CONCLUSIONS

1. ICD is present and reliable landmark in pediatric pelvis
2. Vertical clearance of safe zone increased at all 3 locations across age groups
3. Proportional coverage of vertebral body increased across age groups
4. Decreased margin for error and and increased risk of iatrogenic injury in youngest groups
 - Consider alternative technique such as CT or computer guidance





FIGURE REFERENCE

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- Figure 3. MIO - Iliosacral screw for sacrum for SI-joint fractures. site name. Accessed June 11, 2020. <https://surgeryreference.aofoundation.org/orthopedic-trauma/adult-trauma/pelvic-ring/si-joint/mio-iliac-screw-for-sacrum>
- Figure 4. Shrestha D, Dhoju D, Shrestha R, Sharma V. Percutaneous Ilio-Sacral Screw Fixation in Supine Position under Fluoroscopy Guidance. *Kathmandu Univ Med J.* 2015;13(1):56-60. doi:10.3126/kumj.v13i1.13754
- Figure 5-7. Watzig BF, Peterson DF, Thompson AR, Friess DM, Working ZM, Yang SS. Is the iliac cortical density similarly positioned in the non-dysmorphic developing pelvis? *J Orthop Trauma.* Under review. Submitted 11 May 2020.

